AE-81-09

Noise Barrier Attenuation

Highway 401 North Side, East of Bayview Avenue, North York

Ontario

Ministry of
Transportation and
Communications

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Planning and
Research Division

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M.R. Hunter
Acoustics Consultant

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ABSTRACT

This report presents an acoustical evaluation of the highway noise barrier constructed on the north side of Highway 401, east of Bayview Avenue in North York, during 1980.

The barrier provides average sound reductions of 8.9 and 3.2 dBA for 1.2 m high receivers, unshielded and shielded by houses respectively. Respective reductions of 10.0 and 4.3 dBA were also observed for first and second storey receiver heights in the area immediately adjacent to the highway. Further measurements confirmed that no sound level change resulted for the opposite south side residential community after barrier construction.

Predicted sound level reductions were generally in close agreement with measured values. Thus, predictions can greatly assist in planning optimal barrier height, length and location.

1/ INTRODUCTION

This report continues the series of reports, listed in Reference 1, which acoustically evaluate highway noise barriers constructed by the Ontario Ministry of Transportation and Communications.

The barrier evaluated herein was erected on the north side of Highway 401, east of Bayview Avenue in North York, during 1980. The structure itself consists of corrugated steel panels mounted on metal posts. It is approximately 3356 m in length and varies from 2.4 to 4 m in height as shown by Figure 1.

The acoustical performance of the barrier was assessed by comparing attenuations predicted by a computer program with measured attenuations [2] . The program's output has been modified by reducing the predicted attenuations by a standard value of 2 dBA [3]. All predictions were based on traffic volumes approximating service C levels. These volumes are somewhat larger than the volumes experienced when the sound level measurements were taken. This discrepancy may cause sound level overpredictions but will not affect the magnitude of the sound attenuation predictions.

The instrumentation, measurement and evaluation techniques were similar to those employed previously. For all receiver locations [Figure 1] measurements were conducted at heights of 1.2 m above ground both before and after barrier construction. At locations 9 and 10 additional measurements were also conducted at heights of 6.1 and 4.9 m respectively.

Each measurement location remained identical to its before construction counterpart(s). The measurement procedure also involved two or more sound level monitors being used simultaneously, one monitor at a "control" location and any others at receiver locations. As the difference between each set of control/receiver measurements is independent of traffic volumes, the impact of traffic variations was eliminated when determining barrier insertion loss.

2/ MEASURED AND PREDICTED SOUND LEVELS

Table 1 summarizes the predicted and measured sound level data for the receiver locations surveyed. Further details regarding measurement locations, dates, times and sound levels are presented in Table A1.

2.1/ Before Barrier Construction

Before barrier construction an average 73.7 dBA sound level was measured for the receiver locations unshielded by houses. This is only 1.1 dBA less than its predicted value. For receivers shielded by houses an average of 62.5 dBA was measured, compared to the corresponding predicted value of 66.7 dBA.

2.2/ After Barrier Construction

After barrier construction the receivers unshielded by houses had an average measured barrier insertion loss of 8.9 dBA, which compares favourably with its 8.3 dBA prediction.

Despite the greater acoustical influence of local noises and environmental (weather-related) factors on receivers shielded by houses, the average predicted and measured insertion losses for those receivers were in close agreement as well. Specifically, a 3.8 dBA average attenuation was predicted and a 3.2 dBA average level was measured.

3/ BARRIER IMPACT FOR FIRST AND SECOND STOREYS

Additional measurements were conducted at receiver heights 4.9 and 6.1 m above ground level (Tables 1 and A1). These data provide insights as to the barrier's impact for first and second storey receiver heights in contrast to the usual 1.2 m receiver height.

At location $\overline{9}$, measurements were taken 6.1 m above the local ground elevation (4.3 m above the elevation of the adjacent pavement) and a 10 dBA barrier insertion loss was detected. For location $\overline{10}$, at a 4.9 m height above the local ground and adjacent pavement height, a 4.6 dBA insertion loss was measured. Thus, the barrier apparently provides significant attenuation for roadside receiver locations at first and second storey elevations.

4/ BARRIER IMPACT ON THE HIGHWAY'S SOUTH SIDE

Sound level measurements were conducted at locations A and B (Figure 1, Table A1) at a height of 1.2 m, in order to evaluate the effect the construction of the barrier opposite them might have on south-side residents. No increase in sound level was measured at these locations, probably indicating that construction of the proposed southern barrier will have an insignificant effect on the north side's sound levels.

5/ CONCLUSIONS

1. Receivers unshielded by houses experienced an average 8.9 dBA sound level reduction. The corresponding reduction for receiver locations shielded by houses is 3.2 dBA. Thus, the barrier apparently provides significant acoustical benefit for the north-side community.

2. No change in sound levels was measured in the residential community facing the barrier on the unshielded south side of the highway.

3. In general, measured existing sound levels were in close agreement with predicted levels.

4. The similarity of measured and predicted barrier insertion loss values suggests that predictions can greatly assist in planning optimal barrier height, length and location.

6/ ACKNOWLEDGEMENTS

Messrs. J. Eagan, C. Blaney and J. Desormeaux conducted the field measurements.

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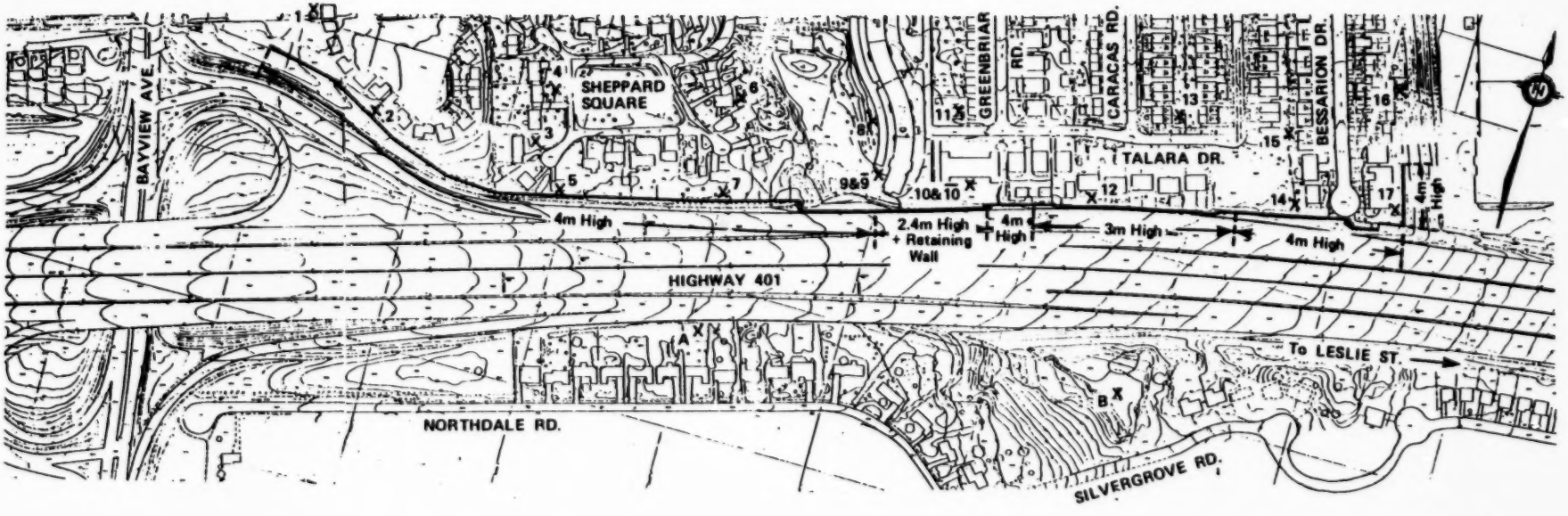
[3] May, D.N., "Noise Barrier Attenuation - Highway 401 South Side, Dixon Rd. to Kipling Ave., Toronto," Report 77-AC-09, Research and Development Division, Ministry of Transportation and Communications, Ontario, November 1977.



SCALE
0 24 48 72 m

Figure 1/ General Barrier Setting

— EXISTING NOISE BARRIER
X MEASUREMENT LOCATIONS

TABLE 1
COMPARISON OF MEASURED AND PREDICTED SOUND LEVELS, Leq, dBA

MEASUREMENT LOCATION NUMBER	PREDICTED SOUND LEVELS BEFORE CONSTRUCTION	MEASURED SOUND LEVELS BEFORE CONSTRUCTION	PREDICTED BARRIER ATTENTUATION*	MEASURED BARRIER ATTENTUATION*
RECEIVERS UNSHIELDED BY HOUSES				
2	71.5	71.0	-8.5	-9.4
5	79.5	80.0	-15.0	-14.3
7	79.0	76.0	-11.0	-10.0
9 1.2 m high	73.5	68.0	-6.0	-7.7
10	73.0	76.6	-4.0	-7.1
12	77.0	77.0	-6.5	-6.3
14	73.5	72.4	-7.0	-10.5
17	71.5	68.4	-8.5	-6.2
Average	74.8	73.7	-8.3	-8.9
RECEIVERS SHIELDED BY HOUSES				
1	66.5	60.5	-3.0	-4.0
3	71.5	68.0	-6.0	-5.6
4	66.5	64.0	-5.5	-7.9
6	69.0	60.0	-5.5	+0.7
8 1.2 m high	70.5	70.0	-3.0	-9.0
11	65.5	60.9	-3.0	-1.8
13	63.5	61.0	-3.0	-3.4
15	65.5	61.6	-3.0	-2.5
16	62.0	56.5	0.0	+4.2
Average	66.7	62.5	-3.8	-3.2
$\overline{9}$ 6.1 m high	°N/A	73.5	N/A	-10.0
$\underline{10}$ 4.9 m high	°N/A	76.5	N/A	-4.6

*Negative signs (i.e., -) denote sound reduction.

°Not available

APPENDIX A

Table A1: MEASURED SOUND LEVELS

Location Number 1)	Measurement		L_{eq}			Measured Insertion Loss	
	Date	Time	Control 2) Meas.	Site 3) Meas.	Difference 4-5	4) L_{eq}	5) L_{50}
1	2	3	4	5	6	7	8
1B	80-7-4	11:24	80	59	21		59
1B	80-8-14	15:45	80	62	18		60
1A	81-7-9	13:30	81.7	58.2	23.5	-4	57
2B	80-7-4	14:15	80	69	11		67
2B	80-8-14	15:10	80	73	7		71
2A	81-7-8	14:15	80.7	64.5	16.2		64
2A	81-7-15	14:50	81	60.3	20.7	-9.4	59
3B	80-7-7	14:40	80	68	12		67
3A	81-7-8	14:15	80.7	60.3	20.4		59
3A	81-7-15	14:50	81	59.2	21.8	-5.6	58
4B	80-7-7	15:30	80	64	16		64
4A	81-7-8	14:15	80.7	56.9	23.8		56.3
4A	81-7-15	14:50	81	57	24	-7.9	56

APPENDIX A

Table A1: MEASURED SOUND LEVELS (page 2 of 7)

Location Number 1)	Measurement		L_{eq}			Measured Insertion Loss	
	Date	Time	Control 2) Meas.	Site 3) Meas.	Difference 4-5	4) L_{eq}	5) L_{50}
1	2	3	4	5	6	7	8
5B	80-7-7	14:15	80	80	0		79
5B	80-8-13	15:25	80	80	0		78
5A	81-7-8	13:30	80.7	66.4	14.3	-14.3	65
6B	80-7-8	14:48	79	60	19		60
6A	81-7-8	13:30	80.7	60.8	19.9		60
6A	81-7-16	14:00	81	61.4	19.6	+0.7	61.5
7B	80-7-8	14:05	79	75	4		74
7B	80-8-13	14:55	80	77	3		75
7A	81-7-8	13:30	80.7	67.6	13.1		67.3
7A	81-7-15	11:05	81	67	14	-10.0	67
8B	80-7-4	11:30	80	67	13		67
8B	80-7-10	9:45	79	72	7		71
8B	80-7-10	10:15	80	71	9		71

APPENDIX A

Table A1: MEASURED SOUND LEVELS (Page 3 of 7)

Location Number 1)	Measurement		L_{eq}			Measured Insertion Loss	
	Date	Time	Control 2) Meas.	Site 3) Meas.	Difference 4-5	4) L_{eq}	5) L_{50}
1	2	3	4	5	6	7	8
8A	81-7-15	14:05	81	62.3	18.7	-9.0	61
9B	80-7-8	14:05	79	66.2	12.8		65.5
9B	80-7-13	13:30	80	68	12		66
9B	80-7-14	13:20	80	69.7	10.3		69.5
9A	81-7-15	14:05	81	62.5	18.5		N/A
9A	81-7-15	13:35	81	60.8	20.2	-7.7	60
$\overline{9}$B	80-7-13	13:30	80	72.9	7.1		72.5
$\overline{9}$B	80-7-14	13:20	80	74	6		72
$\overline{9}$A	81-7-15	13:35	81	64	17	-10.0	64
$\overline{9}$A	81-7-15	14:05	81	65	16		65
10B	80-7-8	15:23	79	77	2		77
10B	80-7-14	14:00	80	76.3	3.7		75.5
10A	81-7-8	15:05	81.7	71.8	9.9	-7.1	71

APPENDIX A

Table A1: MEASURED SOUND LEVELS (Page 4 of 7)

Location Number 1)	Measurement		L_{eq}			Measured Insertion Loss	
	Date	Time	Control 2) Meas.	Site 3) Meas.	Difference 4-5	4) L_{eq}	5) L_{50}
1	2	3	4	5	6	7	8
$\overline{10B}$	80-7-8	15:23	79	74	5		74
$\overline{10B}$	80-7-14	14:00	80	79	1		77
$\overline{10A}$	81-7-8	15:05	79.0	74.4	7.3	-4.6	74.3
11B	80-7-8	14:48	79	60	19		59
11B	80-7-14	15:40	80	61.8	18.2		61.5
11A	81-7-7	14:25	80.7	61.4	19.3		57
11A	81-7-10	13:45	81.7	60.2	21.5	-1.8	59
12B	80-7-9	10:19	81	77	4		77
12B	80-7-14	15:10	80	76.9	3.1		76.8
12B	80-8-13	14:55	80	77.2	2.8		76.8
12A	81-7-7	14:25	80.7	70.5	10.2		70
12A	81-7-10	14:25	80.7	71.6	9.1	-6.3	71.3
13B	80-7-9	10:19	81	61	20		60

APPENDIX A

Table A1: MEASURED SOUND LEVELS (Page 5 of 7)

Location Number 1)	Measurement		L_{eq}			Measured Insertion Loss	
	Date	Time	Control 2) Meas.	Site 3) Meas.	Difference 4-5	4) L_{eq}	5) L_{50}
1	2	3	4	5	6	7	8
13A	81-7-7	14:25	80.7	55	25.7		55
13A	81-7-9	13:30	81.7	60.6	21.1	-3.4	60.5
14B	80-7-4	14:15	80	70.9	9.1		70.5
14B	80-8-14	14:35	80	74	6		72
14A	81-7-7	15:02	81.7	64.5	17.2		64.5
14A	81-7-10	15:30	81.7	63.8	17.9	-10.5	63.5
15B	80-7-9	10:19	81	61.6	19.4		60.8
15A	81-7-9	12:00	80.7	61.3	19.4		60
15A	81-7-15	11:05	81	57.6	24.4	-2.5	55
16B	80-7-8	14:48	79	56.5	22.5		55.0
16A	81-7-15	11:05	81	62.7	18.3	+4.2	59.0
17B	80-7-4	11:24	80	67.1	12.9		66.8

APPENDIX A

Table A1: MEASURED SOUND LEVELS (Page 6 of 7)

Location Number 1)	Measurement		L_{eq}			Measured Insertion Loss	
	Date	Time	Control 2) Meas.	Site 3) Meas.	Difference 4-5	4) L_{eq}	5) L_{50}
1	2	3	4	5	6	7	8
17B	80-7-14	14:35	80	67.2	12.8		66.8
17B	80-8-13	15:25	80	70.8	9.2		70.5
17A	81-7-7	15:02	81.7	63.7	18		N/A
17A	81-7-10	15:00	81.7	64.1	17.6	-6.2	63.8
A(B)	80-7-10	11:25	79	72	7		71
A(A)	81-7-9	11:03	81.7	73.2	8.5	-1.3	72.5
A(A)	81-7-29	14:00	81	73	8		72
B(B)	80-7-10	15:35	82	N/A			N/A
B(B)	80-7-10	11:25	79	64	15		64
B(A)	81-7-9	11:03	81.7	66.2	15.5	-0.9	65
B(A)	81-7-16	14:45	N/A	63.3	N/A		61.5
B(A)	81-7-29	14:30	81.7	65.5	16.2		65

APPENDIX A

Table A1: MEASURED SOUND LEVELS (Page 7 of 7)

NOTES:

1) B - Measurement conducted before barrier construction.
   A - After barrier construction.

2) Control Measurement Location

3) Measurement at the receiver location in question

4) Difference: Average of B minus A from Column 6. Negative numbers indicate attenuation.

5) $\overline{9}$ and $\overline{10}$ are locations 9 and 10, 6.1 and 4.6 m above ground respectively.